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My Eyes are Burning!

Exclusion of the Lens of the Eye in Routine Adult Head CT Examinations:

The Re-Audit

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Conflict of Interest

None



Background

- Irradiation can cause opacification of the lens, leading to cataract formation.
 - Effect = deterministic, threshold of between 0.5 and 2 Gy for detectable opacities for single brief exposures.
 - Visual impairment due to cataract can occur with single brief exposures over 5 Gy
- Exclusion of the lens from the CT head examination
 - Reduce the radiation dose to the eye
 - Reduce likelihood of lens damage and cataract formation.



Background

- Radiation safety with regards to the lens = important consideration in daily scanning practice.
- ICRP 2011 → threshold in absorbed dose for the lens of the eye is now considered to 0.5Gy.
- For occupational exposure, the ICRP now recommend an equivalent dose limit for the lens of the eye of 20 mSv averaged over 5 years with no single year exceeding 50 mSv.
- Public exposure limit unchanged
 - 15 mSv in 1 year



Background

- Many factors influence radiation dose to the lens during a routine CT brain exam.
- Geometry, collimation and filtration
 - Related to the CT scanner itself.
- Factors including X-ray tube potential (kVp), mAs, section thickness, gantry angulation, and overlap
 - Operator dependent.
- Most effective method of reducing radiation to the lens = **exclude the orbit from the primary X-ray beam.**
 - Multiple studies → scans angled to the SOM baseline are most effective at decreasing lens dose.



Background

- Many baselines for a routine CT brain scan are used, including the orbitomeatal (OM) baseline, the supraorbitomeatal (SOM) baseline, and the Reid line.
- Multiple studies → scans angled to the SOM baseline are most effective at decreasing lens dose.
- Tan *et al* in 2008 → even with improvements in automatic tube current modulation technology, the best way to reduce eye lens dose remains repositioning the head or angling the gantry (particularly using the SOM line) to protect the eyes from the beam.



The Cycle

- **The Standard:** All routine head scans should be performed with the base line set so as to exclude the lens of the eye.
- Current protocol for routine CT head
 - SOM baseline perpendicular to the floor to exclude the orbits in order to prevent unnecessary irradiation to the lens OR
 - The chin is tucked down toward chest as much as possible if the baseline is not possible.
- If the patient is unable to tilt their head into satisfactory position for lens exclusion, the gantry is angled to its maximum allowed position to exclude as much of the orbits as possible without compromising inclusion of the brain.



The Standard

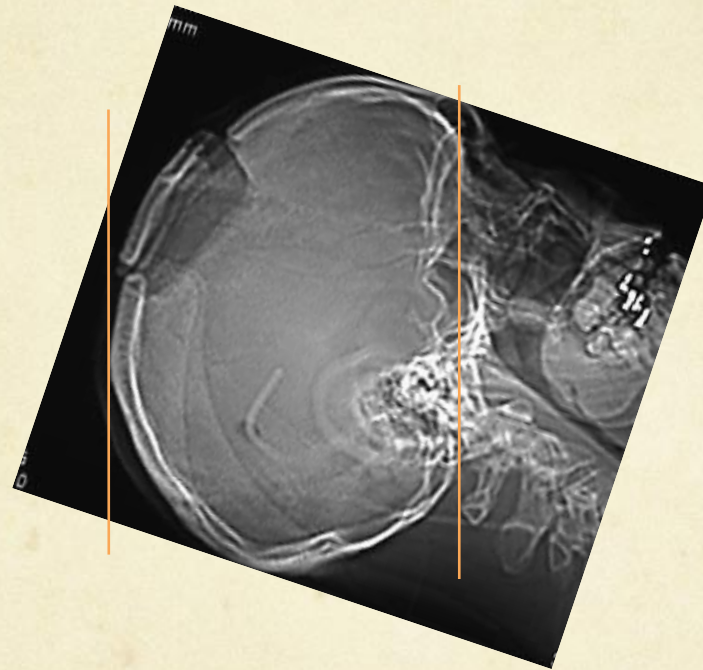


Figure 1: Patient A (above) is a young, flexible adult. They can tuck their chin easily, so the SOM line can be placed perpendicular, no angle is necessary. **Optimal** positioning for a CT Head, orbits excluded.



The Standard

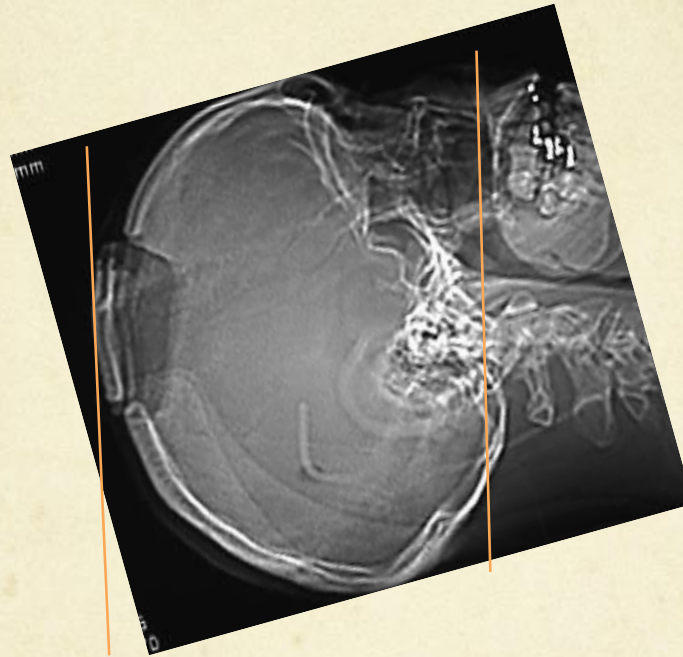


Figure 2: Patient B (above) is in spinal precautions or has limited mobility of the cervical spine. On a CT scanner with no gantry angle possibility, the entire orbit is scanned.



The Standard

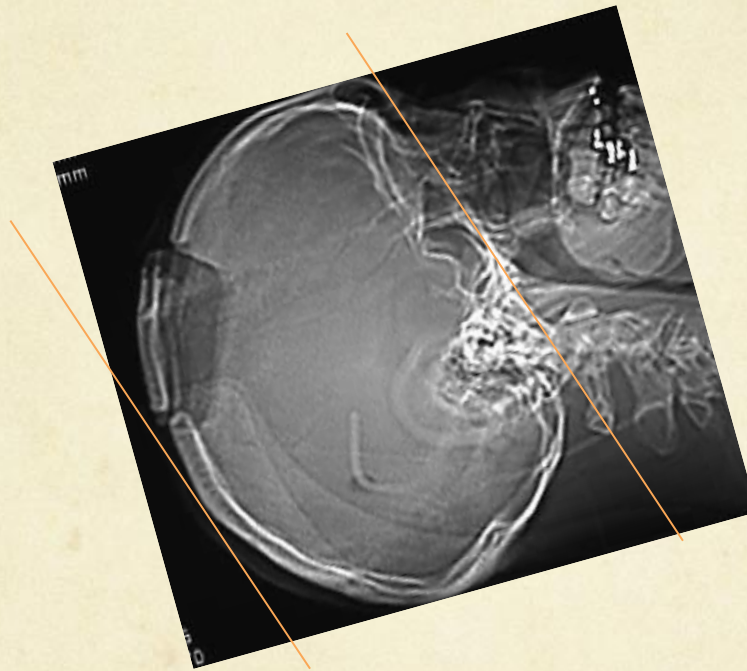


Figure 3: The same patient B, can have some or all of the orbits excluded on an axial scan where the scanner has angling capability. The degree of angulation varies between scanners, can be limited by the table height.



The Cycle and Previous Results

- **Target:** 100%
- **The Indicator:** The percent of routine head CT scans performed with the lens excluded from the scan field.
- 2009 (UAH) 100 routine head CT were reviewed, same inclusion and exclusion criteria.
- 31% examinations reviewed excluded both lenses, 3% included 1 lens, 66% excluded both lenses
- **Intervention =**
 - Disseminate results of audit to CT techs, importance of lens exclusion
 - ER scanner now has gantry angling capabilities
 - Introduction of the GE scanner at the Edmonton Clinic



Methodology

- One hundred (100) consecutive routine CT head examinations at the University of Alberta Hospital and Edmonton Clinic were selected and reviewed
 - Performed December 9, 2013 - December 12, 2013.
- The number of exams in which one, both, or neither of the lens of the eyes were included in the field of view were calculated.
- Only adult routine head CTs were included.



Methodology (continued)

- Exclusion criteria of
 - Trauma
 - Helical scanning, in C-collar (hyperextended) – include orbits so to not compromise inclusion of brain
 - History of requested examination of the orbits
 - History of visual symptoms
 - Pediatric CT
 - Import CT (not done at our center)

Results (2013)

Table 1: Routine CT Head examinations performed on each scanner with one, both or neither lens included in the field of view (2013).

CT Scanner	CT Model / Slice	Number of studies where one lens was included	Number of studies where both lens were included	Number of studies where both lens were excluded ¹	Total number of studies on scanner
ER DEFINITION - AEUAHCTSINAV03 Level 1	SIEMENS - Level 1 - 128 slice - maximum angle up to 18° dependent on table height. Dual source dual energy.	4	18	39	61
FLASH - CTSICAPUAH03 Level 2	SIEMENS - Level 2 - 128 slice - no angle possible	0	3	1	4
SENSATION - UAHCTNAV02 Level 2	SIEMENS - Level 2 - 64 slice - maximum angle up to 18° dependent on table height	0	4	10	14
EDM CLINIC - CTGECAPUAH05	GE Lightspeed - 64 slice- maximum angle 30°	0	8	13	21
Percentage of studies		4%	33%	63%	

1. Where both lens were not included, part of the globe was partially included in the majority of the exams.



Results (2009)

Table 2. Routine CT Head examinations performed on each scanner with one, both or neither lens included in the field of view (2009).

CT Scanner	CT Model / Slice	Number of studies where one lens was included	Number of studies where both lens were included	Number of studies where both lens were excluded ¹	Total number of studies on scanner
ER DEFINITION - AEUHCTSINAV03 Level 1	SIEMENS - Level 1- 128 slice - maximum angle up to 18° dependent on table height. Dual source dual energy.	2	63	27	92
SENSATION - UAHCTNAV02 Level 2	SEIMENS - Level 2 - 64 slice - maximum angle up to 18° dependent on table height	0	1	0	1
CT 1 (Rad. Dept.)	GE Lightspeed 16 slice	1	2	4	7
Percentage of studies		3 %	66 %	31 %	

1. Where both lens were not included, part of the globe was partially included in the majority of the exams.



Results

- 63% of the exams reviewed excluded both lenses, an increase from 31% in 2009.
 - 62% of EC exams (outpatients only) excluded both lenses (n=21).
- 33% of exams reviewed included both lenses, decreased from 66%
- 1 lens included was essentially unchanged, from 3% to 4%.



Discussion

- Since the audit performed in 2009, the percentage of reviewed CT heads with exclusion of both lenses increased from 31% to 63%
- Likely secondary to
 - Tech education
 - ER scanner now has gantry angling capabilities
 - Introduction of the GE scanner at the Edmonton Clinic
 - Can angle gantry up to 30°
 - Majority of outpatients scans are acquired from these two scanners.



Discussion

- A significant proportion of our patients are
 - Trauma (in c-spine restraints)
 - ICU patients that may be intubated
 - Elderly patients with decreased mobility
 - Acutely ill with makes it difficult or impossible to position them properly/maintain proper positioning for the duration of the scan.



Action Plan

- Therefore, it is reasonable to say that at our (tertiary care, Level 1 Trauma center) institution, a standard of 100% of all routine CT head scans excluding both lenses is **not** a reasonable target.
- Of note, 62% of EC exams excluded both lenses
 - No conclusions drawn due to small sample size (n=21).
 - Future directions could focus on this scanner using a larger, more appropriate sample size.



References

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